

CLAIMS

What is claimed is:

- 1 1. An apparatus, comprising:
2 a first region of an optical waveguide disposed in semiconductor
3 material, the first region having a first conductivity type;
4 a second region of the optical waveguide disposed in the
5 semiconductor material, the second region having a second conductivity
6 type opposite to the first conductivity type; and
7 a substantially V shaped insulating region disposed between the first
8 and second regions of the optical waveguide, wherein a vertex of the
9 substantially V shaped insulating region forms an intersecting line that is
10 substantially parallel to an optical path of an optical beam to be directed
11 through the optical waveguide.

- 1 2. The apparatus of claim 1 wherein the substantially V shaped
2 insulating region is formed with at least two regions of insulating material
3 having an intersection at the vertex of the substantially V shaped insulating
4 region.

- 1 3. The apparatus of claim 2 wherein the two regions of insulating
2 material are formed with a substantially orthogonal relationship between
3 the first and second regions of the optical waveguide.

1 4. The apparatus of claim 1 wherein the optical waveguide
2 comprises a rib waveguide, wherein the first region is included in a rib
3 portion of the optical waveguide and the second region is included in a slab
4 portion of the optical waveguide.

1 5. The apparatus of claim 1 further comprising a charge
2 modulated region to be modulated along the optical path of the optical beam
3 and proximate to the substantially V shaped insulating region between the
4 first and second regions of the optical waveguide, the charge modulated
5 region to modulate a phase of the optical beam to be directed through the
6 optical waveguide.

1 6. The apparatus of claim 5 wherein the optical beam is an
2 arbitrarily polarized optical beam including first and second polarization
3 components, wherein a phase modulation of the first polarization
4 component in response to the charge modulated region is substantially
5 equal to a phase modulation of the second polarization component in
6 response to the charge modulated region.

1 7. The apparatus of claim 6 wherein the first polarization
2 component is a transverse magnetic field (TM) mode polarization component
3 of the arbitrarily polarized optical beam and the second polarization

4 component is a transverse electric field (TE) mode polarization component of
5 the arbitrarily polarized optical beam.

1 8. The apparatus of claim 5 wherein the charge modulated region
2 to be modulated in response to a signal coupled to be received by one of the
3 first and second regions of the optical waveguide.

1 9. The apparatus of claim 8 further comprising a first contact
2 coupled to the first region of the optical waveguide and a second contact
3 coupled to the second region of the optical waveguide, the first and second
4 contacts coupled to the optical waveguide at locations outside the optical
5 path of the optical beam to be directed through the optical waveguide,
6 wherein the signal is coupled to be received by a corresponding one of the
7 first and second contacts.

1 10. The apparatus of claim 9 further comprising a buffer region
2 disposed between the optical path of the optical beam and at least one of the
3 locations outside the optical path of the optical beam to which the first and
4 second contacts are coupled to the first and second regions, respectively, of
5 the optical waveguide.

1 11. A method, comprising:

2 directing an optical beam along an optical path through an optical
3 waveguide disposed in semiconductor material;
4 modulating a charge modulated region along the optical path
5 proximate to a substantially V shaped insulating region disposed between
6 first and second regions of the optical waveguide; and
7 modulating a phase of the optical beam in response to the charge
8 modulated region, wherein the optical beam is an arbitrarily polarized
9 optical beam including first and second polarization components, wherein a
10 phase modulation of the first polarization component in response to the
11 charge modulated region is substantially equal to a phase modulation of the
12 second polarization component in response to the charge modulated region.

1 12. The method of claim 11 wherein directing the optical beam
2 along the optical path through the optical waveguide comprises directing the
3 optical beam through the optical waveguide substantially parallel to an
4 intersecting line formed at a vertex of the substantially V shaped insulating
5 region through the optical waveguide.

1 13. The method of claim 11 wherein modulating the charge
2 modulated region along the optical path proximate to the substantially V
3 shaped insulating region disposed between first and second regions of the
4 optical waveguide comprises applying an electrical signal to at least one of
5 the first and regions the optical waveguide, wherein the first region of the

6 optical waveguide has a first conductivity type and the second region having
7 a second conductivity type opposite to the first conductivity type.

1 14. The method of claim 11 wherein the optical beam is an
2 arbitrarily polarized optical beam including first and second polarization
3 components, wherein modulating the phase of the optical beam includes
4 modulating substantially equally a phase of the first polarization component
5 of the optical beam and a phase of the second polarization component of the
6 optical beam in response to modulating the charge modulated region
7 proximate to the substantially V shaped insulating region disposed between
8 first and second regions of the optical waveguide.

1 15. The method of claim 14 wherein the first polarization
2 component is a transverse magnetic field (TM) mode polarization component
3 of the arbitrarily polarized optical beam and the second polarization
4 component is a transverse electric field (TE) mode polarization component of
5 the arbitrarily polarized optical beam.

1 16. The method of claim 14 wherein the substantially V shaped
2 insulating region is formed with at least two regions of insulating material
3 having an intersection at a vertex of the substantially V shaped insulating
4 region, wherein the charge modulated region proximate to the first region of
5 the insulating material is adapted to modulate the phase of the first

6 polarization component an amount substantially equal to an amount that
7 the charge modulated region proximate to the second region of the
8 insulating material is adapted to modulate the phase of the second
9 polarization component.

1 17. A system, comprising:

2 an optical transmitter to generate an optical beam, wherein the
3 optical beam is an arbitrarily polarized optical beam;

4 an optical receiver optically coupled to receive the optical beam; and

5 an optical device optically coupled between the optical transmitter

6 and the optical receiver, the optical device including an optical phase shifter

7 to modulate a phase of the optical beam, the optical phase shifter including:

8 a first region of an optical waveguide disposed in semiconductor
9 material, the first region having a first conductivity type;

10 a second region of the optical waveguide disposed in the

11 semiconductor material, the second region having a second

12 conductivity type opposite to the first conductivity type; and

13 a substantially V shaped insulating region disposed between the

14 first and second regions of the optical waveguide, wherein a vertex of

15 the substantially V shaped insulating region forms an intersecting line

16 that is substantially parallel to an optical path of the optical beam to

17 be directed through the optical waveguide.

1 18. The system of claim 17 wherein the substantially V shaped
2 insulating region is formed with at least two regions of insulating material
3 having an intersection at the vertex of the substantially V shaped insulating
4 region.

1 19. The system of claim 17 wherein the two regions of insulating
2 material are formed with a substantially orthogonal relationship between
3 the first and second regions of the optical waveguide.

1 20. The system of claim 17 further comprising a charge modulated
2 region to be modulated along the optical path of the optical beam and
3 proximate to the substantially V shaped insulating region between the first
4 and second regions of the optical waveguide, the charge modulated region to
5 modulate a phase of the optical beam to be directed through the optical
6 waveguide.

1 21. The system of claim 20 wherein a phase modulation of the first
2 polarization component in response to the charge modulated region is
3 substantially equal to a phase modulation of the second polarization
4 component in response to the charge modulated region.

1 22. The system of claim 17 wherein the optical phase shifter is
2 included in an optical modulator included in the optical device, the optical

3 modulator to modulate an amplitude of the optical beam directed from the
4 optical transmitter to the optical receiver.

1 23. The system of claim 22 wherein the optical modulator includes
2 a Mach-Zehnder interferometer (MZI) configuration having first and second
3 arms, wherein the optical phase shifter is included in at least one of the first
4 and second arms to modulate the optical beam directed through the MZI
5 configuration.

1 24. The system of claim 22 wherein the optical modulator includes
2 a Fabry-Perot cavity configuration, wherein the optical phase shifter is
3 included in Fabry-Perot cavity configuration to modulate the optical beam
4 directed through the Fabry-Perot cavity configuration.